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MODERN METHODS AND TECHNIQUES OF FILTRATION AND SORPTION PROPERTIES OF SORBING MATERIALS

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Abstract. *There are numerous methods of water purification, adsorption and filtration which are quite simple, effective and economical methods of wastewater treatment. This article explains the concept of adsorption, and filtration. Attempts have also been made to describe in more detail modern methods used in this domain.*

Keywords: *wastewater, purification, filtration, sorption, adsorption.*

Water is the most important component for life on earth; however, the availability of drinking water is a serious global problem of the 21st century. Clean and uncontaminated water is a basic requirement for all living organisms. More than 71% of the earth's surface is covered with water, but only less than 1% of the water is drinkable, according to international standards, due to various contaminants. The main sources of water pollution are the discharge of wastewater from industrial enterprises, agricultural activities, municipal wastewater, environmental and global changes. The heavy metals, dyes and microorganisms, even in trace amounts, are very dangerous for human health, water systems and the environment. Therefore, it is necessary to find ways to reduce this pollution.

One of the most common methods of water purification from pollutant products is filtration. It is used to reduce the concentration of fine petroleum products in the treated waters. This method is often used in settling tanks or after biological purification. The process is based on the adhesion of coarse particles of pollutants to the surface of the filter material [1].

There are different types of filters used for wastewater treatment containing petroleum products:

- fabric or mesh filters;
- frame or alluvial filters;
- granular or membrane filters for car wash wastewater treatment.

However, it should be noted that all the advantages of this water purification scheme are fully disclosed only when cleaning a large amount of wastewater contaminated with petroleum products. Filtration of oily wastewater through the granular loading layer occurs in two stages: delivery of particles to the loading grains and their adhesion to the grains. The working area during filtration is the surface of the material and the space between the loading grains. During liquid filtration, the geometric structure of the loading continuously changes as a result of the deposition of oil particles on the surface of the grains. With the existing variety of technological methods of filtration and engineering designs of this process, the efficiency of filters with the same hydrodynamic parameters is determined by the interaction of the filter loading material with petroleum products. Effective removal of undissolved petroleum products from water is achieved due to the ability of petroleum products to adhere to the surface of the filter loading material, which is present to varying degrees on all solid surfaces. The correct selection of the granular loading largely determines the filtration efficiency, which depends on the properties of the filter material (size, shape, roughness) and the geometric structure of the layer (layer porosity, the size of individual intergranular pores, grain uniformity). The main physico-chemical parameters of widely used filter materials are given in Table 1.

Table 1

Physic-chemical parameters of some granular filter materials

Indicator	**Sand**	**Hydroanthracite-R**	**Volcanic tuffs**	**Swollen vermiculite**
Grindability, %	2.9	1.7	0.8	2.9
Abradability, %	0.7	0.2	0.3	0.3
Ash content, %	0.2	0.1	4.5	0.5
Oxidizability, mg/l	9.7	9.2	7.5	6.2
Silicic acid, mg/l	5.0	0.8	3.5	2.5
Dense residue mg/l	8.7	19.7	12.6	9.3
Residual content of petroleum products in water, mg/l	3.0-5.0	1.5-2.5	3.0-3.5	1.0-2.5

On the basis of the indicators in the table, it can be concluded that the best fillers providing the highest quality water treatment are hydroanthracite-R. But these materials cannot extract dissolved forms of petroleum products from water due to the small internal surface of the particles and because of the low total value. When using peat as a filter material to remove undissolved petroleum products, there is a possibility of contamination of the purified water with organic impurities present in peat [1,2].

To improve the quality of filtration, namely, to enhance the specific potential of the adsorption forces of the surface layer of various natural materials, their enrichment with carbon additives is used during thermal or chemical treatment (vermiculite with various additives, shungite modified with carbon fiber,

hydrophobized expanded clay, etc.). Increasing the carbon content at the surface layer of filter loadings increases the efficiency of their use for purification from insoluble hydrocarbons.

Another technique used in the field of treatment and purification of pollutants from water is sorption which is derived from *sorbeo* (Latin) meaning 'to absorb'. It is a process of extraction from drinking water transmitted through special absorbent materials (sorbents) of dissolved impurities. Sorption allows removing almost all impurities from a solution (water).

Sorption processes are regulated by some laws, which considerably complicate both construction of adsorption nozzles and their service. They are the law of absorption edge formation, law of parallel transfer, Shilov equation, law of equilibrium concentration, etc.

Due to these laws, harmful impurities contained in water transmitted through sorbents are accumulated in the sorbent. As a result of the equilibrium concentration law, they enter treated (filtrate) water already while in service, long before the end of the service life, turning it into "pure" water. These features were studied in the development of sorption field of water treatment plants [3].

The sorption process (Fig.1) is characterized by two mechanisms, absorption and adsorption. Absorption is the process in which a fluid is dissolved by a liquid or a solid (absorbent). Adsorption (Fig.2) is the process in which atoms, ions or molecules from a substance (it could be gas, liquid or dissolved solid) adhere to a surface of the adsorbent. Adsorption is a surface-based process where a film of adsorbate is created on the surface while absorption involves the entire volume of the absorbing substance.

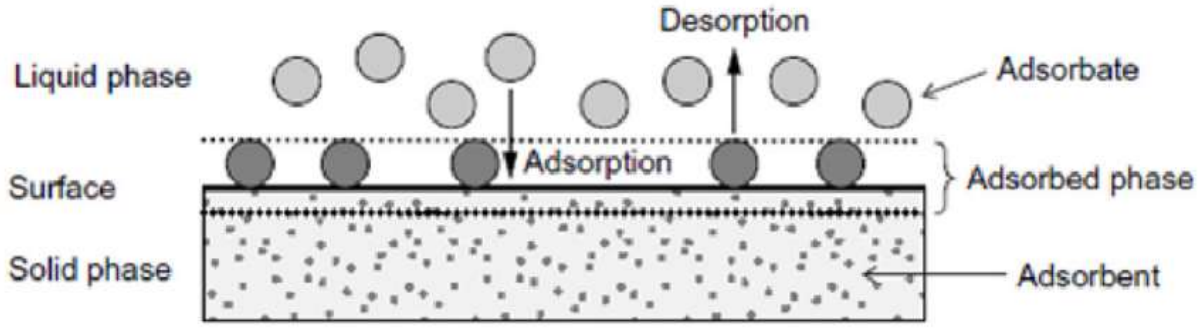

Figure 1 Basic terms of sorption (Watch, 2012)

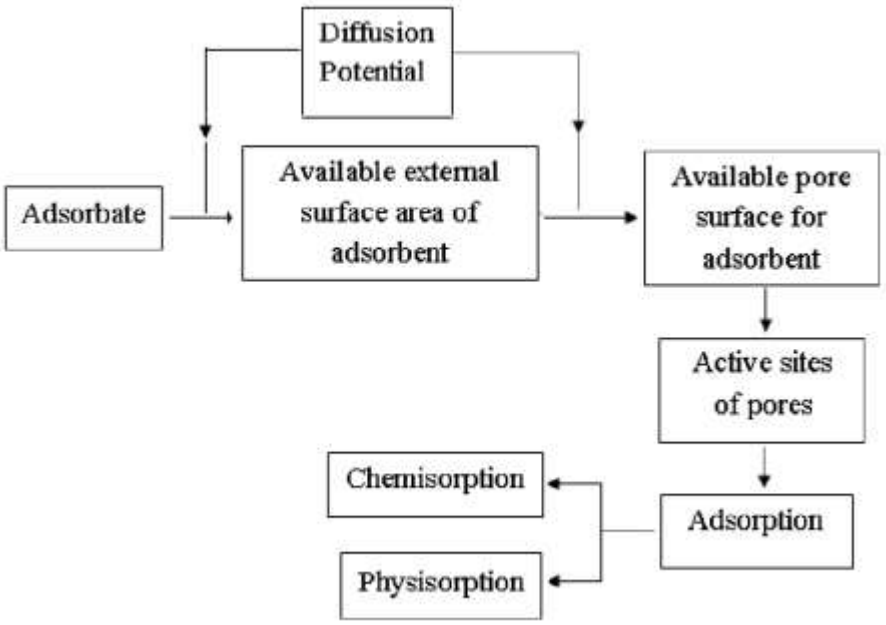

Figure 2 Adsorption process pathways (Lata and Samadder, 2016)

Adsorbents used in water purification are divided into the following categories (Fig. 3)

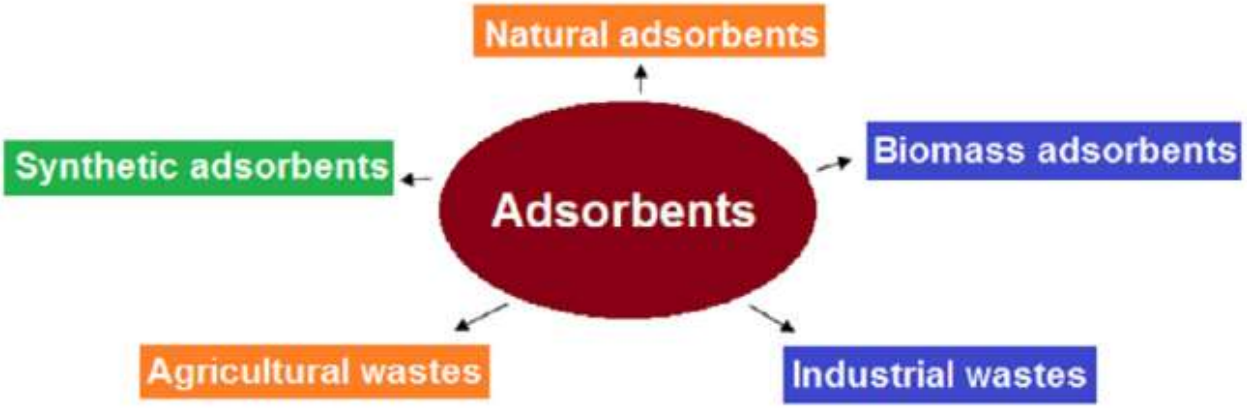

Figure 3 Adsorbents for water purification

Because of simplicity and cost effectiveness, the adsorption technique is considered to be suitable for wastewater treatment. The adsorbent selection for removal of water contaminants depends on concentration and the type of pollutant present in the water, efficiency and adsorption capacity for pollutant. Additionally, the adsorbents should be non-toxic, cost effective, easily available, and they should be easily regenerated. A large number of adsorbents such as natural materials, agricultural wastes and residues, industrial byproducts and biomass materials have been used for purification of water and wastewater [4,5].

To conclude, the article describes the most important techniques used in water purification. The results of the previous research carried out in the field of filtration and absorption show the efficiency of the techniques, but with some

disadvantages that are associated with the difficulty of securing absorption materials or in terms of the high cost of the materials used. Therefore, it is advisable to conduct more experiments in order to identify new materials that can be used and accessed easily and at lower costs.

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SUSTAINABLE INTENSIFICATION OF CROP PRODUCTION: INTERCROPPING

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***Abstract:** Intercropping is currently a common method of diversifying crop production in world practice, based on the cultivation of two or more genotypes or types of crops simultaneously on the same piece of land. The most common benefit of intercropping is higher yields through judicious use of the available growth resources by component crops. Combining legumes and grains improves soil fertility and health through symbiotic biological nitrogen fixation with bacteria. In addition, the combination of legume crops reduces cost of production by reducing*